Effect of Storage of Raw and Pasteurized Goats' Milk on Flavor Acceptability, Psychrotrophic Bacterial Count, and Content of Organic Acids

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ABSTRACT

Pasteurization of raw goats' milk either at 63°C for 30 min or 72°C for 15 s within 1 d of milking ensures a better tasting product both initially and during storage at 4.5°C for 6 weeks than if the raw milk is aged for several days at 4.5°C before being pasteurized. Pasteurized milks processed from high-count raw milks aged 1 to 2 weeks had lower acceptability ratings (on a 9-point hedonic scale), which decreased further in cold storage and were independent of bacterial increases in the log phase of growth. Pasteurized milks processed from raw milk 7 or more days old were subject to rapid increases in bacterial numbers in storage if they were trace-contaminated during pasteurization even though initial counts were <100 psychrotrophs/ml. For all raw and pasteurized milks, three peaks were consistently observed from an HPLC analysis designed to monitor some organic acids. Two of the components decreased and the third appeared and increased during storage. Disappearance of one component coincided with appearance of another. These compounds may be associated with loss of flavor quality of the milk since in some instances these changes significantly correlated with the decrease in hedonic ratings of the stored milks.

Most goats' milk is produced on small farms from small herds which frequently are a source of milk to the immediate neighborhood. Some medium-size or larger herds furnish milk to processors of fluid milk and specialty products such as ice creams, yogurts, spray dried whole milk, and cheese. Much milk is sold raw and may be collected, transported, and held for 2 to 5 d or longer before processing further. Because of a limited milk supply, a common practice is to pool milks of disparate age to obtain sufficient amounts to make further-processing feasible. A frequent consumer complaint is the rancid, "goaty" off-flavor of the milk when marketed.

A voluminous literature exists describing the on-farm collection procedures and processing parameters affecting the bacterial quality and flavor of cows' milk (*2,4,7,8,13*). The widespread use of farm bulk tanks for milk storage has increased the problem of milk spoilage from growth of psychrotrophic bacteria (PB) in refrigerated milk (*15*). Although conventional methods of milk pasteurization may destroy most of the PB, the bacterial metabolites or enzymes released by the PB may be heat resistant (*2,7*). Post-pasteurization contamination with PB can also be a problem unless care is taken to thoroughly clean the lines and filters leading out of the pasteurization chamber (*3,7*).

Information is lacking about the growth of PB in goats' milk during storage and its relation to the development of undesirable flavors. A survey has been conducted to ascertain the public health significance of unpasteurized goats' milk produced and marketed in New South Wales (NSW), Australia during August-December, 1978 (*9*). Although total PB were not enumerated in the study, results indicated that food poisoning bacteria such as *Staphylococcus aureus* and *Yersinia enterocolitica* were present in a significant number of samples and could represent a hazard to public health. Of 291 samples of raw milks obtained from retail outlets and farms, 24.4% had SPC $>10^6$/ml and only 36.4% $<10^4$/ml. Hankin and Shields (*4*) demonstrated that there was no correlation of keeping quality of raw cow and goat milk with any microbial count made at the time of collection, except for the numbers of coliforms present, but they did not examine pasteurized goat milk.

In an effort to improve the acceptability of fresh fluid goats' milk, we studied the processing and storage conditions that might influence its flavor and bacteriological quality. Detailed organoleptic and bacteriological tests of stored raw and pasteurized milks were conducted, with emphasis on the enumeration of PB.

It has been reported that raw goats' milk contains less alkaline phosphatase than raw cows' milk and that the enzyme is destroyed at lower time—temperature levels than required for proper pasteurization of cows' milk (*12*). Lythgoe (*10*) reported that alkaline phosphatase activity is reduced to minimal levels when goats' milk is heated to 62.5°C for 5 min. Therefore, we tested our samples for alkaline phosphatase to determine if this enzyme could be used as a criterion for the proper pasteuri-

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zation of goats' milk under our experimental conditions. Lythgoe also reported that bacterial counts may be very low in fresh goats' milk. Of 133 milkings an average SPC of 1730/ml was obtained.

A quantitative HPLC anlaysis of the organic acids present in cows' milk and processed dairy products was reported recently (*11*). This study showed that 10 organic acids could be separated and quantitated with a total analysis time of less than 1 h per sample; less than 0.01% of each organic acid could be detected. It seemed to us that analysis of the organic acids in goats' milk by HPLC could supply support data for our microbiological and organoleptic studies by quantitating such bacterial metabolites as pyruvic, lactic, formic, acetic, and propionic acids. If successful, this technique could provide regulators with a rapid means of assessing the age and quality of raw and pasteurized goats' milk for sale in retail outlets. Therefore, we investigated formation of organic acids in stored goats' milk as another means of defining acceptability.

MATERIALS

A blend of milks from one herd consisting of about 60 goats of Toggenbergs, Nubians, and Saanens was used as the main source of milk. Nubian milk was also obtained from a second source because of problems of availability.

Processing

Refrigerated raw goats' milk was obtained from the previous days' milking and pasteurized at once or refrigerated in cans at 4 to 5°C for further processing at a later date. Milk was pasteurized at 72°C for 15 s (HTST) in a small pilot plant unit. The milk was run directly into chlorine-rinsed plastic bottles and promptly cooled. It was stored at 4 to 5°C until further evaluated.

Milk was also pasteurized at 63°C for 30 min (LTP) in pint jars. Seven of these jars fitted with screw-cap lids, and rings were sterilized. After filling with milk they were held in circular canning wire racks and submerged in water of 68°C; the bath was adjusted to 63.5°C and the rack gently moved back and forth to mix the milk. A jar of milk in the middle of the rack was fitted with a thermometer secured in a rubber stopper and held in place by a screw-cap ring. A temperature of 63°C was attained within 19 to 20 min. At the end of 30 min heating at 63°C, the jars of milk were chilled to 6 to 10°C in 15 min in an ice bath. To simulate home or small processing plant conditions, milk was LTP-pasteurized in uncovered or loosely covered 1-gal stainless steel containers. To pasteurize, the container with cold milk was set in a bath at 68°C, the bath was adjusted to 63.5°C, and the contents hand-stirred with a spoon. At the end of the 30-min heating period, the container was placed in an ice bath where a temperature drop to 30°C was obtained in 5 to 6 min. The milk was chilled further to 6-10°C and transferred with a sterile funnel into pint or quart plastic bottles that had been rinsed with 200 ppm chlorine.

For differential growth experiments, 13-ml portions of goats' milk were pasteurized in submerged 16 × 150 mm screw-capped culture tubes before incubation. A come-up time of 2 min was needed to obtain 63°C and a cooling time of 2-3 min to obtain 4°C.

Analyses

Aerobic plate count, coliforms, and PB (10 d at 7°C) were determined according to Standard Methods for the Examination of Dairy Products (*1*). PB counts were also determined on Standard Plate Count agar held for 48 h at 20°C and compared to those of PB held 10 d at 7°C. Milk was incubated for 48 h at 32°C on Pseudomonas agar to determine *Pseudomonas* sp.

Total solids and fats were determined according to the instructions from the Milk Industry Foundation (*12*). Phosphatase was determined by a modified rapid Scharer Phosphatase test (*1*) using the Phosphatase Kit Model D (Applied Research Institute - Perth Amboy, NJ)[2].

Organic acids were determined in milks by HPLC (*11*) with a few modifications. A DuPont column compartment and 870 pump module were used in conjunction with a BioRad HPX-87H$^+$ column held at 65°C and eluted with 0.009 *N* sulfuric acid. The system was equipped with a manual 23-μl loop injector and a Gilson Holochrome ultraviolet/visible detector. Calculations were made on a Hewlett Packard 3390A integrator in an external standard, peak height mode with the following parameters: attenuation = 7, chart speed = 0.3 cm/min, peak width = 0.16, threshold = 7, area rejection = 2000. Column effluents were analyzed at a wavelength of 220 nm and 0.1 AUFS. The flow rate of the system was kept at either 0.6 or 0.7 ml/min. An aqueous organic acid calibration standard was prepared containing 1100 ppm citric acid, 143 ppm pyruvic acid, 2773 ppm lactic acid, 2015 ppm acetic acid, 2024 ppm propionic acid, 2573 ppm butyric acid, and 18 ppm hippuric acid. Before injection into the chromatograph, the goats' milk samples were treated as described in (*11*). Statistical analyses, including correlation analyses, were done by the ERRC Statistical Service.

Oragnoleptic evaluation

Organoleptic evaluations were conducted in a light- and temperature-controlled panel room under the supervision of an experienced panel administrator. Judges consisted of a group of 8 to 10 laboratory personnel who had received minimal training in the judging of goats' milk, but were experienced tasters; several were experienced dairy products judges.

Samples for tasting were withdrawn from storage at weekly intervals, coded, and the milk served at room temperature. Fresh containers of milk were used at each panel.

"Goatiness," rancidity, and other off-flavors were judged on a 5-point intensity scale of 0-4 where the higher numbers represent more intense flavor. "Goatiness" may best be described as a musky, rancid off-flavor, and odor which leaves a distinct aftertaste and is generally regarded as objectionable.

Samples were also rated for acceptability on a 9-point hedonic scale (*14*). Our panel size was smaller than that usually employed for this type of panel because only limited quantities of samples were available for tasting.

RESULTS AND DISCUSSION

Goats' milk may be held raw for several days while sufficient is accumulated for further-processing. Potential also exists for temperature-abuse of both raw and pasteurized milks during transport to market and while stored

[2]*Reference to brand or firm name does not constitute endorsement by the U.S. Department of Agriculture over others of a similar nature not mentioned.*

in the dairy case awaiting retail sale. Under these conditions, rapid bacterial growth could be promoted not only in raw milks, but especially in pasteurized aged raw milks, even though initial counts are low. Therefore, we examined bacterial numbers in raw and pasteurized milks. PB counts in aged raw and aged LTP Nubian goats' milk were made up of large numbers of *Pseudomonas* sp. (Table 1). The pseudomonads also constituted sizeable percentages of the total bacteria in fresh and 1-month old aged, pasteurized milk and in fresh and 9-d old raw milks. Only <10 coliform bacteria/ml were found in stored pasteurized milks.

The PB count of pasteurized 1-d old raw milks (HTST-1) (10.2% total solids, 2.7% fat) remained below 10^2 during storage at 4.5°C for at least 6 weeks (Fig. 1). PB counts were determined using both 10-d incubation at 5 to 7°C (data not shown) and 2-d incubation at 20°C. Results showed that there was little difference between PB counts at the two incubation times and temperatures. Because of this, all subsequent incubations were carried out at 20°C for 2 d. The bacterial population (CFU/ml) rapidly increased in raw milk, attaining 7×10^6 within 8 d and 5×10^7 within 11 d of storage at 4.5°C. Pasteurization of these aged raw milks (HTST-8 and 11) lowered the counts to 100 CFU/ml or less. The PB count of HTST-8 during subsequent storage did not significantly change after 6 weeks but HTST-11 did increase in count after 5 to 6 weeks.

The age of raw goats' milk when pasteurized significantly influenced the initial panel scores of milks pasteurized by HTST (Fig. 2). Similar results were reported for LTP pasteurized cows' milk (*7*). Goats' milk HTST-pasteurized from 1-, 8-, or 11-d old raw milks (HTST-1, HTST-8, and HTST-11) had initial ratings of 7.34, 6.25, and 4.22, respectively. Although the panel score of the raw milk decreased from 7.12 to 6.25 after 1 week of storage, it was still acceptable. Because the PB counts of raw milk aged beyond 1 week increased to $>10^7$/ml, no tastings of these milks were carried out. The panel scores of milks pasteurized by HTST from 1- and 8-d old stored raw milk negatively correlated ($P<.05$) with length of storage, decreasing during storage times of up to 6 weeks at 4.5°C. HTST-11 milks received the lowest scores over the storage period.

Milk can deteriorate in flavor because of the action of bacterial proteases and lipases. It has been suggested that

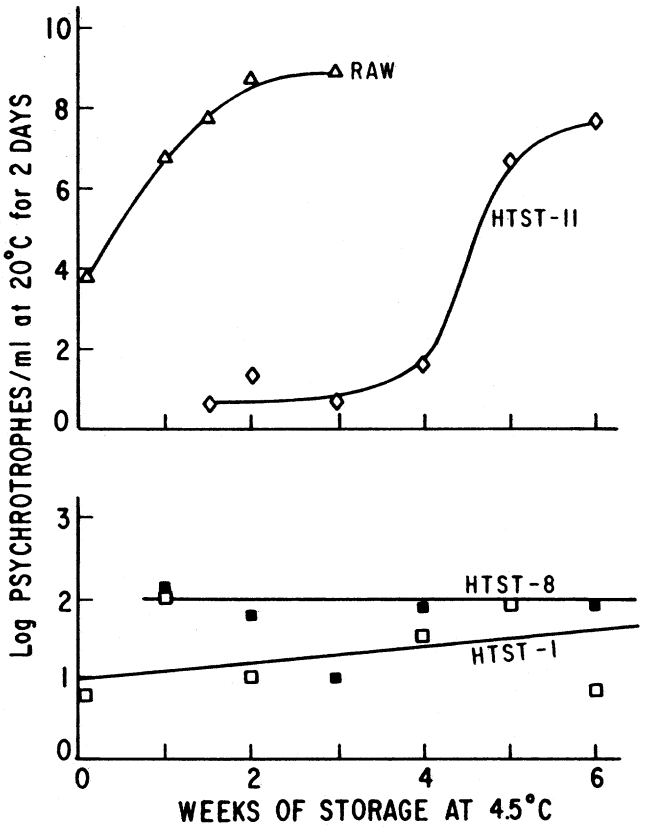

Figure 1. *Psychrotrophic bacterial counts (20°C for 2 days) of stored goat milks. Numbers are time in days raw milk held at 4.5°C before pasteurization.*

goaty flavor may arise from lipolytic activity, but Hankin and Shields were unable to correlate keeping quality of raw goat milk with bacterial count or lipase activity (*4*). Intensity of goaty off-flavor doubled in raw milk stored for 8 d at 4.5°C (Fig. 3). Although variable, goaty flavor generally increased during storage of pasteurized 1-d old raw milk (HTST-1). Highest levels of goaty flavor were found in milk pasteurized after 11 d of storage (HTST-11), but little change in intensity occurred during subsequent storage of the pasteurized milk. HTST-8 milk showed similar results. Increase in goaty flavor intensity could be correlated ($p<.01$) with decline in hedonic ratings, but there was no correlation between intensity ratings and PB count in the pasteurized milks.

Because much goats' milk is pasteurized and bottled on kitchen stoves or under other conditions where recon-

TABLE 1. *Comparison of total, psychrotrophic bacteria, coliform, and* Pseudomonas *sp. counts/ml of raw and pasteurized Nubian goat milks.*[a]

	Counts before pasteurization			Counts after pasteurization					
	Raw			P_1G[b]		P_4G		P_9G	
Bacteria	1-day old	4-days old	9-days old	Initial	1-mo old	Initial	1-mo old	Initial	1-mo old
Total	1×10^4	1.8×10^5	6.3×10^7	650	3.3×10^4	540	>40	720	5.7×10^8
Psychrotrophs	1×10^3	2.8×10^5	8×10^6	20	3.7×10^4	<10	1.3×10^4	<10	3.3×10^8
Pseudomonas sp.	2.2×10^3	3.6×10^4	4×10^6	288	2.6×10^4	180	240	320	3.8×10^7
Coliforms	1.3×10^3	1.4×10^3	7.8×10^2	<10	<10	<10	<10	<10	<10

[a]4.3% total fat, 14.2% total solids.

[b]P_1G goat milk pasteurized (63°C 30 min) from 1-d-old raw; P_4G from 4-d-old raw; P_9G from 9-d-old raw milk.

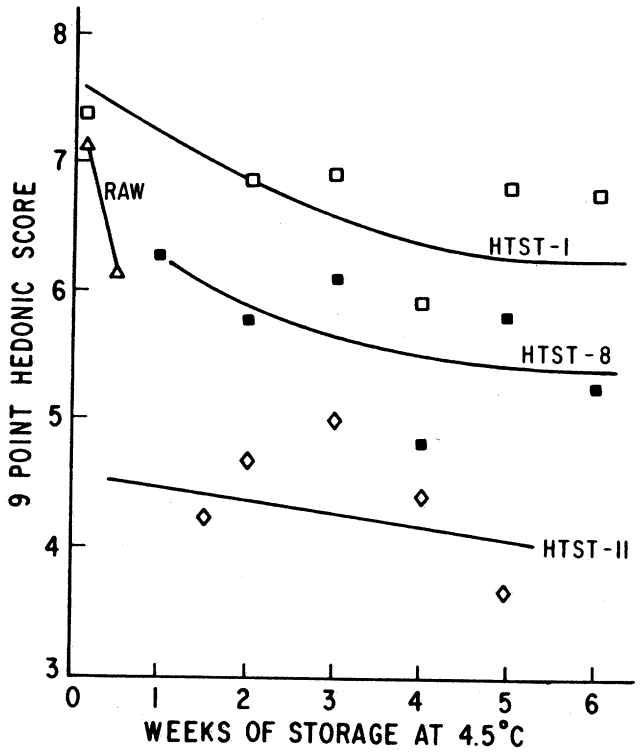

Figure 2. *Ratings on a 9-point hedonic scale of stored goat milks. Nos. time in days raw milk held at 4.5°C before pasteurization. Δ=Raw; □=HTST-1; ■=HTST-8; ◇ =HTST-11.*

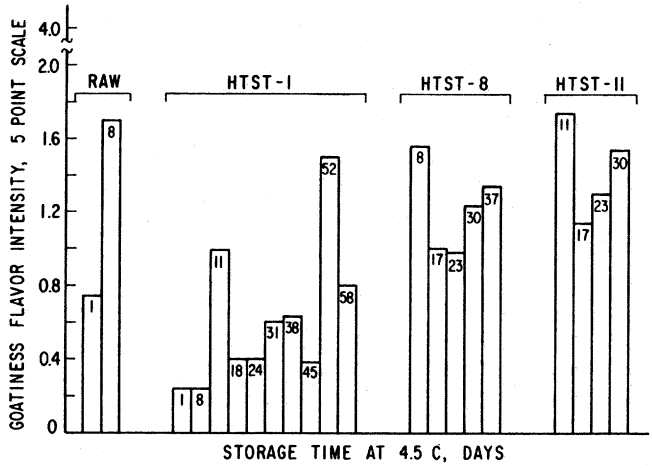

Figure 3. *Intensity of goaty off-flavor in raw and HTST pasteurized stored goat milks (5-point scale).*

tamination could easily occur, we investigated the effects of LTP pasteurization at 63°C for 30 min on keeping quality. We attempted to simulate conditions that might be found on a small farm by using open or loosely covered containers for pasteurization; milks were also pasteurized in sealed jars for a control.

Raw milks (12.8% total solids, 3.9% fat) were LTP-pasteurized after holding for 2, 8, or 12 d at 4.5°C. Pasteurization in this experiment was carried out either in sealed jars submerged in water or in loosely covered gallon containers. PB counts of all LTP milks stored in the sealed jars did not significantly increase (Fig. 4). PB

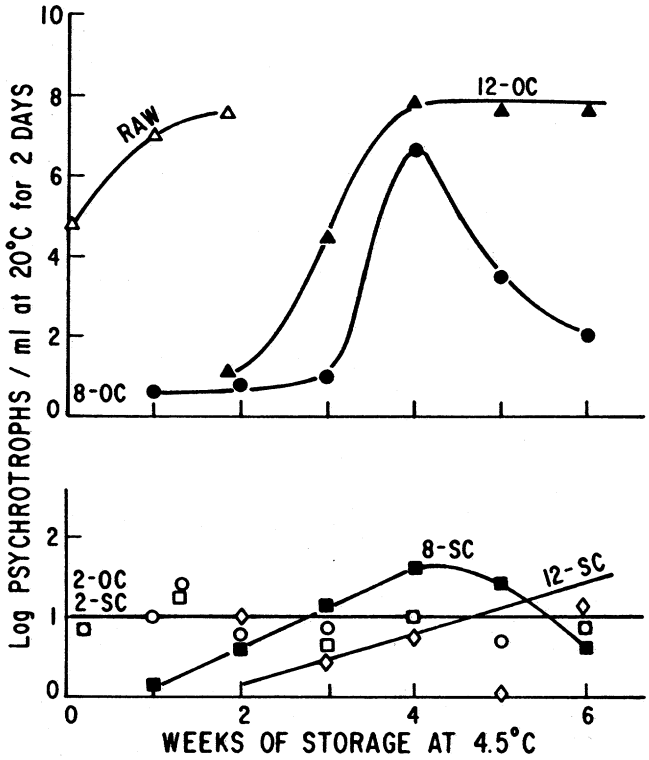

Figure 4. *Psychrotrophic bacterial counts of stored goat milks pasteurized at 63°C, 30 min. Numbers are time in days raw milk held at 4.5°C before pasteurization. OC—loosely covered container. SC—sealed container submerged in water.*

counts of the same milks pasteurized in loosely covered gallon containers after 8 and 12 d of storage (LTP–8 and LTP-12) increased very rapidly, showing that recontamination with viable organisms occurred even though initial counts for these milks were very low (Fig. 4).

LTP-12 milks produced very low hedonic ratings regardless of pasteurization container (Fig. 5). The milks were rated unacceptable immediately following pasteurization and ratings declined still further during 2 weeks storage. Average intensity scores of 2.0 to 2.4 for "goatiness" and scores of 2.2 to 2.7 for rancidity were also obtained.

LTP-2 and LTP-8 milks were generally rated acceptable, with the LTP-8 milks receiving lower ratings during the storage period after pasteurization. Ratings were not affected by the type of pasteurization container used. Increases in CFU of up to 10^7/ml in LTP-8, pasteurized in the gallon container (Fig. 4) were not a significant influence in flavor deterioration.

In additional experiments, goat milks held raw at 4.5°C for several days were heated in gallon containers with the cover off during the come-up heating period of 20 min; the cover was then replaced during holding at 63°C for 30 min. Covers were also left off during the entire preheating, holding, and initial cooling periods. One 7-d old raw milk contained 2.7×10^6 CFU/ml and the other 10-d old raw milk, 2.5×10^7 CFU/ml. The PB counts of any of these milks after pasteurization did not rise above 10^2 CFU/ml during up to 6 weeks of cold storage, dem-

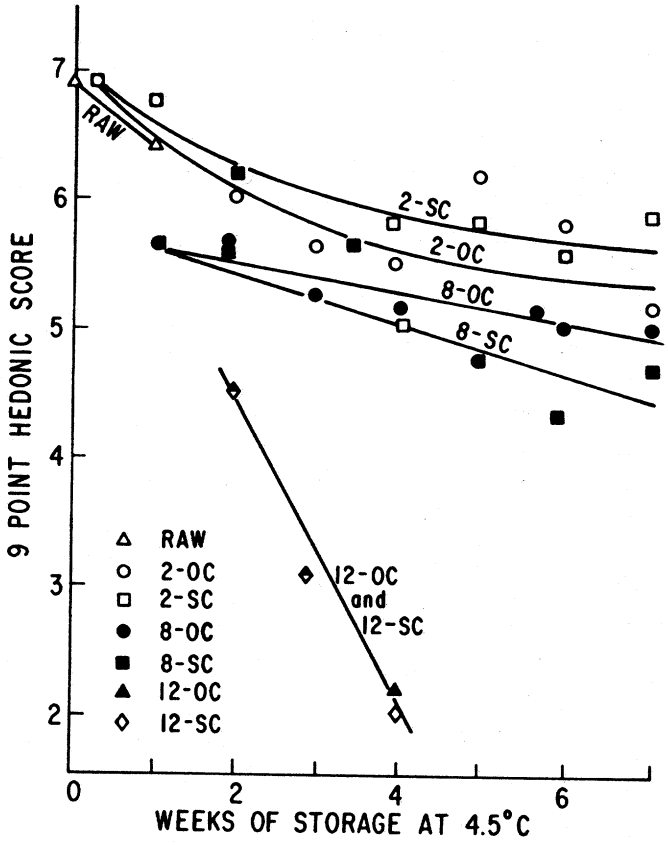

Figure 5. *Ratings on a 9-point hedonic scale of stored goat milks pasteurized at 63°C, 30 min. Numbers are time in days raw milk held at 4.5°C before pasteurization. OC—loosely covered container. SC—sealed container submerged in water.*

onstrating that recontamination did not occur under these conditions.

The bulk of the PB were inactivated during the 20-min come-up time to 63°C. Raw milk analyzing 1.85×10^6 CFU/ml contained 30 CFU/ml by the time the milk reached 63°C. Holding 30 min longer produced 50 CFU/ml. Raw milk analyzing 1.1×10^7 CFU/ml assayed 210 CFU/ml by the time the sample reached 63°C. Holding 30 min longer produced a count of 80 CFU/ml.

To examine effects of recontamination on the rate of bacterial growth, we conducted experiments in which the milk was pasteurized at 63°C for 30 min in screw-capped culture tubes submerged under water. Raw milk was aged 1, 8, and 15 d before being pasteurized. All pasteurized milks were held at 4.5°C before being simultaneously inoculated on the 16th day. The inoculum was 16-d-old raw milk serially diluted with sterile peptone water to yield 100 PB/ml. Milks were incubated at both 4.5°C and 25°C and periodically sampled for plating. The results of PB counts made after plate incubation at 20°C for 48 h showed that all inoculated milks increased their count at the same rate (Table 2). All uninoculated controls contained 40 PB/ml or less at any incubation time. Our results show that proliferation of PB rapidly occurs in both fresh and aged milks even when recontamination is as low as 100 CFU/ml.

TABLE 2. *Effect of age of raw goats' milk before pasteurization (63°C, 30 min) on growth of psychrotrophic bacteria (PB) during storage of pasteurized milks inoculated with 100 PB/ml.*

	Age of raw milk when pasteurized[a]		
Sample	1 day	8 days	15 days
Pasteurized[b] before inoculation	0	0	<10
Inoculated	90	140	115
Inoculated, incubated 25°C			
6 h	800	1150	1080
12 h	2.7×10^4	4.2×10^4	3.5×10^4
24 h	3.8×10^6	5×10^6	4.2×10^6
48 h	6.2×10^7	6.4×10^7	6.5×10^7
Inoculated incubated 4.5°C			
4 days	14×10^4	11×10^4	8.5×10^4
7 days	8.1×10^6	3.6×10^6	3.1×10^6
14 days	8.6×10^7	8.8×10^7	8.3×10^7

[a]Counts of raw milks before pasteurization = 1 day, 22 PB/ml; 8 days, 500 PB/ml; 15 days, 8×10^6 PB/ml.
[b]All subsequent stored controls <40 PB/ml.

Results for all pasteurized samples, regardless of age, usually showed only slight decreases in pH and titratable acidity, even when bacterial numbers were high. In all samples stored for 6 weeks at 4.5°C, pH decreased by only 0.1 unit. Titratable acidity increased by only 0.02 to 0.03%, to a greater extent in milks pasteurized from aged raw milk than fresh milk. To follow these changes in detail, the organic acid content of all milks was monitored by HPLC. A standard chromatogram of organic acids shown to be present in various dairy products (*11*) is given in Fig. 6a. Citric acid (Peak 1) consistently occurred in all milk samples; concentrations ranged from 0.04 to 0.07% (Fig. 6b). Conspicuous by its absence in most samples was lactic acid (Peak 3), even in samples of high bacterial count, an indication of the absence of lactic acid-producing organisms. Only scattered amounts of acetic (Peak 4) and pyruvic acid (Peak 2) were detected. Butyric acid (Peak 6) was present in many samples that had been stored raw for several days before pasteurization. Confirmation that the changes observed in the HPLC profiles were the result of organic acids indicated in Fig. 6b was accomplished as follows: the goat milk extract was passed through Duolite A 561 anion exchange resin to trap the organic acids. The resin was washed with water and the extract analyzed by HPLC. None of the organic acid peaks identified in Fig. 6b was detected in this eluate. After washing the resin with 50% formic acid, the eluate contained the organic acids shown in Fig. 6b.

The most significant changes observed in the HPLC profiles for most samples was a peak (Peak C, 15.2-min retention time at 0.7 ml/min flow rate) that had the same retention time as propionic acid (Fig. 6a, b). Gas chromatographic analysis using a diethylene glycol succinate column showed that this compound was not propionic acid. Furthermore, spiking goats' milk samples with

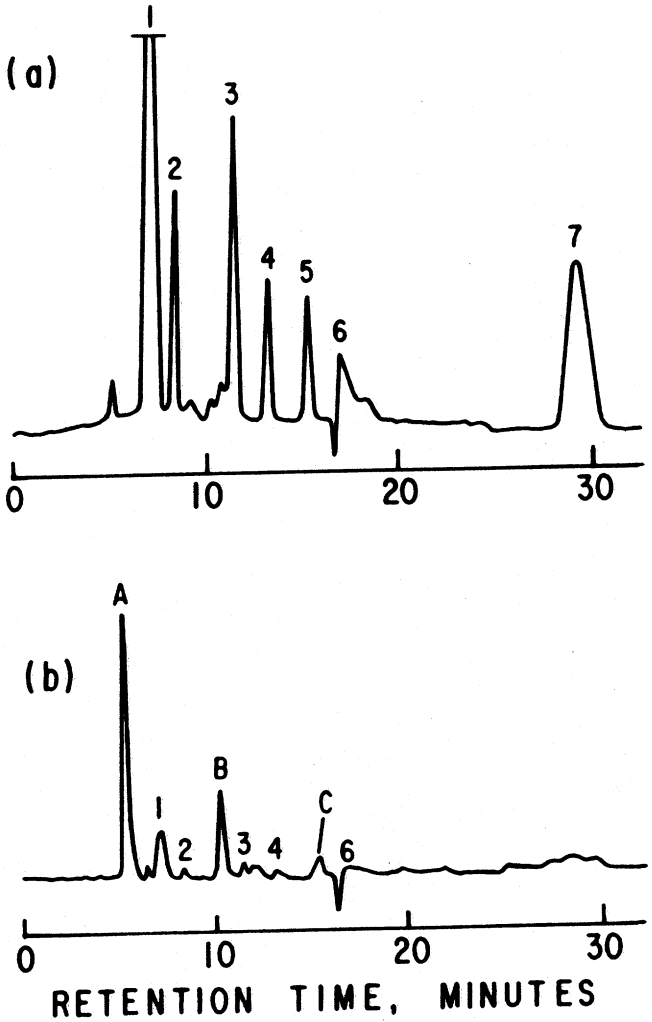

Figure 6. *HPLC chromatograms (BioRad HPX-87H$^+$ column) of organic acids in goat milk compared to the standard mixture. Flow rate 0.7 ml/min of 0.009* N *sulfuric acid. Column temperature 65°C.*

a. standard mixture.

b. Low temperature pasteurized goats' milk.

Peaks A, B, and C = unknown compounds. Peak No. 1 = citric acid, Peak No. 2 = pyruvic acid, Peak No. 3 = lactic acid, Peak No. 4 = acetic acid, Peak No. 5 = propionic acid, Peak No. 6 = butyric acid, Peak No. 7 = hippuric acid.

the amount of propionic acid calculated to be present from the HPLC profiles (about 1%) decreased the pH of the samples to 4.5, significantly below the observed values of 6.5. Also, this material was not absorbed on the anion exchange resin used to trap previously identified organic acids.

In addition to the peak corresponding to the retention time of propionic acid (compound C), two other unknown compounds (compounds A, retention time 5.4 min and B, retention time 10.3 min at 0.7 ml/min flow rate) were detected at various concentrations in both raw and pasteurized milks. Component B was also not sufficiently acidic to be trapped on anion exchange resin. A raw milk aged 8 d before pasteurizing showed a significant reduction in the concentration of compound A, disappearance of compound B, and appearance of compound C during a 5-week storage period at 4.5°C (Fig. 7). Compound B decreased in stored raw milk coincident with the increase in compound C (Fig. 8a). The concentration of compound B gradually increased during storage in 1-d-old raw milks pasteurized by either technique (LTP or HTST) while the concentration of compound C was negligible (Fig. 8b). However, if the raw milks were aged for 8 or 11 d before either LTP or HTST pasteurization, the concentration of compound B, as measured by peak height, decreased rapidly and disappeared from both samples after 3-5 weeks of storage at 4.5°C while compound C increased to a maximum in 5 to 6 weeks (Fig. 9a, b).

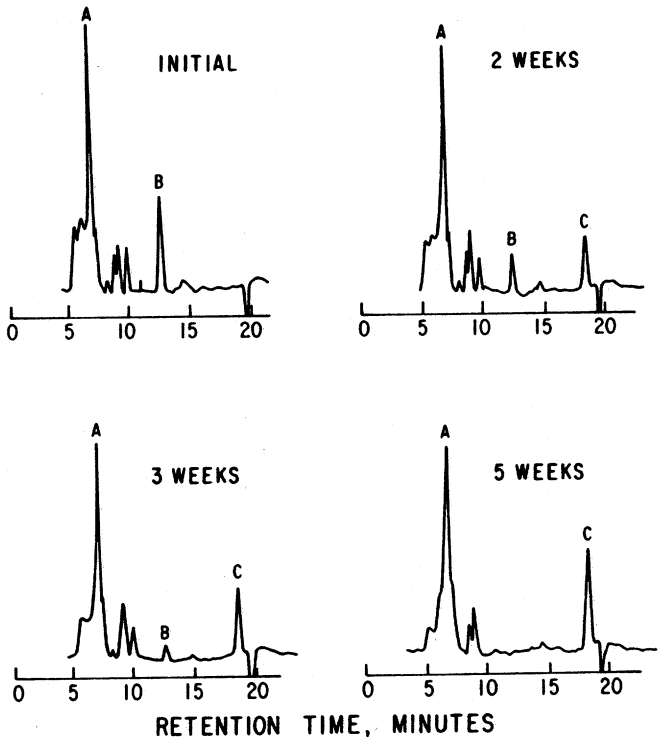

Figure 7. *Effect of storage at 4.5°C of goat milks pasteurized from 8-d-old raw milk at 63°C for 30 min on HPLC tracings of unknowns A, B, and C. Flow rate 0.6 ml/min.*

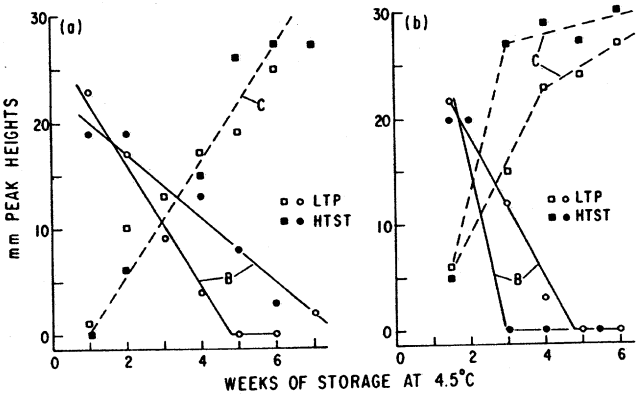

Figure 8. *Relationship of peak heights of unknown compounds B and C of raw (a) and pasteurized (b) 1-d-old goat milks to storage time at 4.5°C.*

In some instances, the decrease in peak heights significantly correlated with hedonic panel scores of goat milks. In both LTP-1 and HTST-8 milks, peak heights of compound A significantly correlated ($P = .03$) with their panel scores, both decreasing with time of milk storage (Table 3). The peak height of compound B also significantly correlated ($P = .02$) with the decrease of panel scores of LTP-8 milk. Although other correlations of panel scores with peak heights were not significant at the 5% level, they were significant at slightly higher levels. The panel scores of LTP-1 stored milk correlated negatively at the 6% level with peak heights of compound B. Panel scores of LTP-8 stored milk correlated negatively with the peak height of compound C at the 10% level. Whereas these compounds (A, B, C) may not be directly responsible for the observed changes in flavor scores, it is noteworthy that these correlations exist.

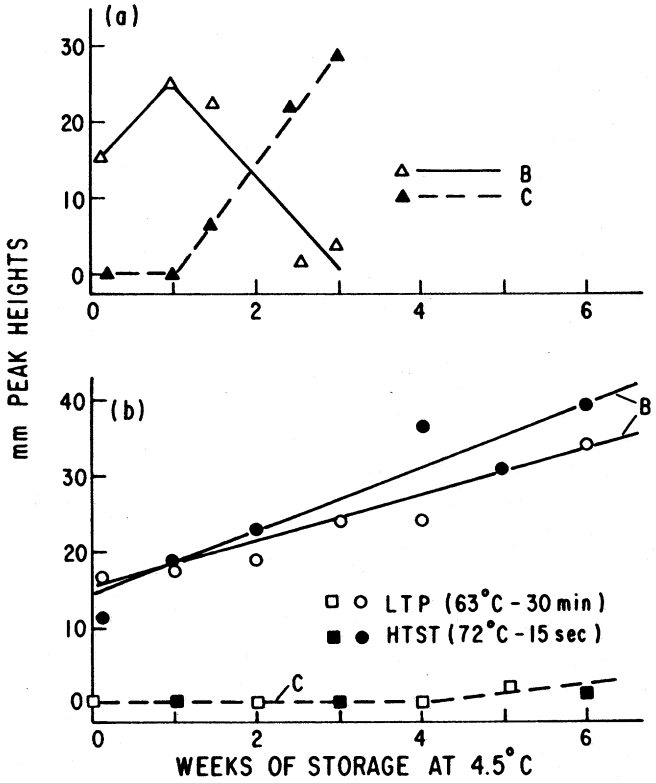

Figure 9. *Peak heights of unknown compounds B and C from goat milks stored raw at 4.5°C for 8 d* (a) *or 11 d* (b) *before pasteurization.*

Compound A was present in all goat milk samples analyzed. Regardless of the age or pasteurization conditions, the concentration of this compound decreased slightly during storage. Compounds B and C appear to be related since the appearance of C is always coincident with a decrease in B. Furthermore, the appearance of compounds B and C may also be related to the decrease observed in the concentration of compound A. The relationship of the three compounds was further inferred by HPLC isolation of each compound. Rechromatography of the isolates on the same HPLC column showed each to give homogeneous peaks with the expected retention times. Compounds A, B, and C were not found in raw cows' milk stored up to 19 d at 4°C, indicating the possible unique presence of these materials in goats' milk. Compounds B and C have now been identified as uridine and uracil, respectively; characterization of these compounds forms the subject of another paper (*5*).

All raw goats' milk samples gave strong positive phosphatase tests and all fully pasteurized milks gave negative tests. One sample heated to 59°C for 30 min had two units residual phosphatase activity, demonstrating that, in contrast to Lythgoe's report (*10*), under our experimental conditions, the Scharer phosphatase test was also suitable for goats' milk.

CONCLUSIONS

Goats' milk of excellent flavor, bacteriological quality, and storage stability could be produced by pasteurizing

TABLE 3. *Correlation of peak heights of compounds A, B, and C with 9-point hedonic panel scores of goat milks.*

	LTP-1[a]				LTP-8[b]				HTST-8[c]			
	Peak Heights (mm)				Peak Heights (mm)				Peak Heights (mm)			
Weeks storage at 4.5°C	A	B	C	Panel score	A	B	C	Panel score	A	B	C	Panel score
0	68	16	-	7.6	-	-	-	-	-	-	-	-
1	69	17	-	7.0	67	23	1	6.1	67	19	0	6.25
2	64	19	-	6.6	65	17	10	5.9	60	19	6	5.7
3	58	24	-	6.4	63	9	13	5.1	62	0	22	6.1
4	64	24	2	6.5	51	4	17	5.0	49	13	15	4.8
5	59	31	-	6.1	49	0	19	-	60	8	26	5.8
6	62	34	-	6.8	48	0	25	-	42	3	27	5.25
7	47	22	-	6.0	-	-	-	-	-	-	-	-
8	61	57	-	5.8	-	-	-	-	-	-	-	-
Correlation coefficient	0.70	−.64	-	-	.79	.98	−.90	-	.86	.44	.12	-
Probability >R	.034	.065	-	-	.21	.022	.099	-	.028	.45	.85	-

[a]Milk held raw 1 d at 4.5°C before pasteurizing at 63°C for 30 min.
[b]Milk held raw 8 d at 4.5°C before pasteurizing at 63°C for 30 min.
[c]Milk held raw 8 d at 4.5°C before pasteurizing at 72°C for 15 s.

fresh milk no more than 1 or 2 d old. Holding of the chilled raw milk for several days before pasteurization, a common home and commercial practice, decreased the flavor quality both initially and during storage at 4 to 5°C. Psychrotrophic bacteria numbers of high count raw milk were decreased to low levels initially and remained low during storage, provided the milk was properly pasteurized. Flavor defects in these milks increased during storage independently of changes in bacterial numbers. Raw milk maintained an acceptable flavor score for up to 1 week of storage, but increases in bacterial numbers if the milk is stored longer without pasteurization could pose a potential hazard to public health as well as produce serious flavor defects. This study shows the susceptibility of goats' milk to contamination with psychrotrophic bacteria and, as with cows' milk, emphasizes the role of proper pasteurization in producing a milk of good keeping quality. The presence of three unknown compounds, two of which have been identified as uridine and uracil, detected on HPLC chromatograms in goats' milk may provide regulators with a rapid means of identifying aged milk samples.

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